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em Economia
da Fundação
Getulio Vargas

Nº 542 ISSN 0104-8910

Monetary union and productivity differences in mercosur countries

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Abril de 2004

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March 2004

[1]The authors gratefully acknowledge the financial support from the AECI. M. Camarero and C. Tamarit also thank projects SEC2002-03651 (Spanish Ministry of Science and Technology and FEDER) and AVCiT Project Groups03-151. They are also indebted to Leonardo Souza, who wrote the Matlab code to compute the FPS test, and to J.B. Breuer, R. McNown and M. Wallace for their RATS procedure to compute Sarno and Taylor's and their own test. P. Perron provided the RATS codes for the unit root analysis with structural breaks.

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Abstract

This paper investigates cross-country productivity convergence among Mercosur members plus associates (Chile and Bolivia) and Peru, during the period 1960-1999. The testing strategy is based on the definitions of time-series convergence by Bernard and Durlauf (1995), and applies sequentially the multivariate unit root tests proposed by Sarno and Taylor (1998), Flôres, Preumont and Szafarz (1995) and Breuer, Mc Nown and Wallace (1999). The last two tests allow to identify the countries that converge. Our results show evidence of convergence among the four Mercosur countries, using either Argentina or Brazil as benchmark. Weaker evidence of convergence is also found with Bolivia. The results point out that monetary union among the Southern Cone economies, though a far objective, is not without sense .

Keywords: Stochastic convergence, SUR estimation, multivariate unit root tests, productivity convergence, Mercosur.

JEL classification: C32, O40.

1 Introduction.

Evolution of regional integration in America is far from being clear, with the creation of a continental Free Trade Area for the Americas (FTAA) sometimes being seen either as an alternative or as a complement to some of the already existing integration processes, as Mercosur. On the other hand, the view that corner solutions are the only viable exchange rate options is becoming increasingly widespread; the logical outcome being a regionalization of world currencies into few groups, whose common currencies float against each other.

The debate about a future monetary union in Mercosur, as an alternative to dollarization[1] or currency board strategies[2], is always present when furthering the integration is at stake. Mercosur, as many, like Levy-Yeyati and Sturzenegger (2000), have already assessed, is far from achieving the necessary pre-requisites suggested by the traditional optimum currency areas literature. However, because monetary union remains a goal to achieve in the long run, a more appropriate question should be whether the present integration dynamics is generating a real convergence process.

As implicitly stressed in the seminal paper by De Grauwe (1975) and recently discussed in IDB (2001, 2002) for the case of Latin America, inside a currency union, the exchange rate can only be used to gain competitiveness against third countries and not against other countries in the union. Therefore, the relationship between wages and productivity is determinant to keep a sustainable territorial equilibrium, in terms of economic activity and employment, inside the bloc. Divergent productivity paths can only be offset by increasing differences in wages, something that can be done only to a limited extent and for a short period of time. This leaves the success of a monetary union very dependent on macroeconomic policy coordination in the short run and of productivity convergence in the long run. Consequently, before any attempt to monetary integration is taken, the analysis of the productivity differences across Mercosur countries is a key aspect to be addressed. Moreover, the diverging productivity path experienced by Argentina vis-à-vis the US, together with its commercial dependence on Brazil at a regional level, became the most important obstacle to keep its exchange rate commitment after 2001.

Analysis of the convergence hypothesis has regained interest as a result

[1] See in volume 23 of the *Journal of Policy Modeling* (2001) a special issue on dollarization, summarized in Salvatore (2001), where the costs and benefits of dollarization in America are discussed.

[2] For a short review of previous initiatives on monetary integration, see Temprano (2002).

of new developments in the theory of economic growth. Research has concentrated on the question of convergence of per capita GDP but much less so on labor productivity and/or Total Factor Productivity (TFP) convergence. The new theoretical developments stress the importance of R&D activities to foster long-run growth (Romer, 1990). Moreover, economic integration, either at a global or regional level, facilitates the diffusion of technologies and constitutes a source of growth for less technologically advanced countries (Grossman and Helpman, 1991 and Barro and Sala-i-Martin, 1997).

Notwithstanding, the question whether technological spillovers provide a way towards international productivity convergence remains open from an empirical viewpoint. In two seminal papers, Bernard and Jones (1996a, 1996b) found evidence of TFP convergence for a group of OECD countries. More recent studies, like García Pascual (2000), have documented mixed evidence against TFP convergence, when analyzing more heterogeneous groups of countries. From a theoretical point of view, despite the use of common technologies in different countries, productivity differences may persist in the long-run, due to differences in social infrastructure, such as institutions and government policies, or as a result of a different supply of skilled workers across countries (García-Pascual, 2000). The empirical findings for Latin America and, more explicitly, for the Southern Cone are rather scarce and non-conclusive; Muendler (2002) addresses the case of Brazil and Pavcnik (2000) that of Chile. The little evidence surveyed in IDB (2002) points to learning-by-exporting gains on Mercosur trade and to some relevance of the import-discipline effect.

We investigate here the extent of convergence in aggregate labour productivity using annual data for the period 1960-1999. Differences in the sectoral mix, technology level or in capital intensity may account for productivity disparities in the short run. Moreover, the relative price of labour is an important driving force behind the observed processes. However, our purpose here is not to discover the sources of labour productivity, but to assess whether productivity differences among Mercosur countries are persistent or tend to disappear.

According to Tyrväinen (1998), for many purposes, labor productivity is the most useful productivity measure, being more robust than most of the alternatives as it eliminates biases in cross-country comparisons due to differences in participation rates. Hourly labour productivity would be the most relevant measure to assess international differences in competitiveness. Unfortunately, as working hours may differ across countries, and were not available for any of those studied here, we examine labour productivity on a per employee basis.

The multivariate econometric specification adopted relies on the time

series definition of convergence proposed by Bernard and Durlauf (1996). Their definition implies that the presence of a unit root or of a deterministic component in the series of productivity differences (with respect to the most productive country) constitutes evidence against convergence. Bernard and Jones (1996b) extended this definition to a multivariate framework by using panel data unit root tests to investigate productivity convergence.

Overall, the advantage of the multivariate approach is that, by jointly considering the whole set of countries, it enhances the power and efficiency of the tests. The multivariate unit root tests used here provide three significant improvements over those previously employed in the study of productivity convergence. First, they allow for the parameters in the panel specification to vary across countries. Second, they account for the presence of cross-country correlations in the data. Third, when the null hypothesis of non-convergence is rejected, a second test determines the number of and identifies the converging countries.

This paper is organized as follows. In the second section, we briefly summarize the process of monetary integration in the Southern Cone, while in section three we present the definitions of convergence used and describe the testing hypotheses and techniques. The fourth section discusses the empirical results and their policy implications; the last one concludes.

2 The monetary integration debate in Mercosur.

Economic integration between Argentina and Brazil started in the mid 80's on a bilateral basis. However, it was fostered and widened in 1991, after signature of the *Asunción Treaty*. This Treaty initiated the process for the creation of a common market among Argentina, Brazil, Paraguay and Uruguay, the so-called Mercosur or Southern Cone Common Market.

The Treaty established that a customs union should be effective on January 1st 1995. In December 1994, the Ouro Preto Summit modified somehow the pre-agreed schedule. An imperfect customs union did begin on January 1st 1995 and it is expected that, by 2006, all exceptions will have disappeared and a full customs union will be in operation.

Since its creation, Mercosur has suffered from recurrent trade tensions among its members, caused by divergent macroeconomic developments and sharp fluctuations in their real exchange rates. In order to manage this problem, Mercosur launched, in 2000, an initiative to foster coordination of

the macroeconomic policies: the Macroeconomic Monitoring Group (MMG). From September 2000, the member countries started publishing harmonized indicators for fiscal deficit, debt and inflation.

However, a little later, Argentina entered in a great crisis, experiencing a currency devaluation, sovereign debt default and a freeze on bank accounts, after ten years of one-to-one parity with the US dollar. During this period, Argentina privatised nearly all state-owned enterprises and opened itself to international trade. Brazil, through the Mercosur customs union, became Argentina's largest trading partner, though one big obstacle to Argentinean exports was the appreciation of the dollar, and thus of the peso, against other major currencies. From 1995 onwards, this made Argentinean goods relatively expensive to the rest of the world. During the mid-1990s, when Brazil was also pegging to the US dollar, Argentina and Brazil were roughly in the same boat, but Brazil unilaterally devalued the real in January 1999. Without a nominal devaluation of the peso, the only way market forces could reduce the real exchange value of the peso was for prices in Argentina to fall relative to prices in the US. This was not possible, given the US productivity boom which held down US inflation and raised the real rates of return, what implied higher real borrowing costs in Argentina's domestic credit market.

Argentina did not attend any of the two meetings the MMG held in 2001, the year the crisis exploded. After an extremely hard 2002, prospects have improved and a new Argentinean government, elected in 2003, is again supportive of Mercosur's monetary integration. Indeed, once Argentina decided to abandon its currency board agreement in January 2002, the interest in monetary integration with Mercosur was reinforced as a way of establishing a credible monetary regime[3]. At the same time, Brazil seems to be interested in re-launching the process of regional integration as an alternative to the continental one led by the US. Under this framework, the assessment of real convergence becomes a key factor for future decisions.

3 Defining and testing convergence in a multivariate time series context.

Bernard and Durlauf (1995) defined long-run convergence for more than two countries, calling it *multivariate convergence.* Thus, countries $i = 1, ..., n$ converge if the long-term forecasts at a fixed time t, of the variable of interest

[3]However, such a regime may create serious problems for Argentina and Uruguay due to their high degree of dollarization, unless Argentina's current "repesofication" strategy succeeds.

(productivity in our case), are equal for all countries:

$$\lim_{k \Rightarrow \infty} E(y_{1,t+k} - y_{i,t+k} \mid I_t) = 0 \qquad \forall i \tag{1}$$

Similarly, countries $i = 1, ..., n$ contain a single *common trend* if the long-term forecasts of output are proportional at a fixed time t.

This condition has been widely applied to study the existence of convergence. A main problem in the empirical applications is that convergence is a gradual and on-going process. As Bernard and Durlauf (1996) pointed out, with the classical cross-section tests - like those on average growth rates of the considered variable across a sample of countries (β convergence), or on measures of dispersion of the variable across countries over time (σ convergence) - economies are assumed to be in transition towards a unique steady state (absolute convergence), and initial differences should tend to shrink over time. Different steady states can also be considered (conditional convergence), introducing other explanatory variables (Barro and Sala-i-Martin, 1995) or using panel data with fixed effects. However, with time series tests, *economies are assumed to be near the steady-state equilibrium*. Not surprisingly then, time series evidence has not been, in general, supportive of the convergence hypothesis. Ben-David (1994) and Quah (1994), using the Summers-Heston data, did not find conclusive evidence of convergence among a large number of countries. Campbell and Mankiw (1989) and Bernard and Durlauf (1995) failed to find convergence among OECD countries.

Notwithstanding, the literature has recently benefited from new developments in the area of multivariate time series tests. Specifically, two strands have experienced an intense development: panel unit root techniques and multivariate unit roots tests. Levin et al. (2002) and Im, Pesaran and Shin (1999) proposed different versions of unit root tests in a panel setting, whereas Hadri (2000) built stationarity tests for panels. Although all these tests are being extensively used in the field, their main drawback is the assumption (common to all) of absence of correlation across the "individuals" in the panel. This assumption cannot be maintained in the majority of the cases, especially when the countries analyzed are neighbours or are involved in integration processes. Multivariate unit root tests, in contrast, do not impose this assumption but rather, by resorting to the more efficient SURE technique, incorporate the error covariance matrix in the estimation.

We outline below the multivariate tests applied in the next section to assess productivity convergence in Mercosur. The tests are used sequentially. In a first stage, two versions of a test for non-convergence among a group of countries is applied (either the first stage of the Flôres et al. (1996) test or the MADF test proposed by Sarno and Taylor (1998)). As these tests do

not identify the countries that effectively converge, if non-convergence has been rejected, in a second stage, we use two more tests (multivariate SURE versions of the DF and the ADF tests) to identify which are the converging countries.

3.1 Multivariate unit root tests I: no identification of countries outside the convergence club.

Sarno and Taylor (1998)'s multivariate augmented Dickey-Fuller test (MADF)

In the Multivariate ADF test proposed by Sarno and Taylor (1998) - see also Taylor and Sarno (1999) -, the sum of the autoregressive coefficients may vary across countries under the alternative hypothesis. Let's denote by $dy_{it} = y_{1t} - y_{it}$[4] the process of the deviations from the benchmark; their test, *MADF* hereafter, considers an N-dimensional stochastic process[5] defined by:

$$dy_{it} = \mu_i + \sum_{j=1}^{k_i} \rho_{ij} dy_{it-j} + u_{it} \tag{2}$$

for $i = 1, ..., N$, where N denotes the number of series in the panel. The disturbances $\mathbf{u}_t = (u_{1t}...u_{Nt})'$ are assumed to be independently, normally distributed, with zero means and a constant (not necessarily diagonal) contemporaneous covariance matrix. The ρ coefficients are allowed to differ across the panel members and heterogeneous lag lengths are also possible.

In contrast to the standard *ADF* test, that involves testing separately each of the N nulls of non-stationarity, Sarno and Taylor (1998) estimate system (2) by the *SURE* method, taking into account the contemporaneous correlations among the disturbances. Their joint null is:

$$H_0 : \sum_{j=1}^{k_i} \rho_{ij} - 1 = 0, \qquad \forall\ i = 1, ..., N \tag{3}$$

and is tested by way of a Wald statistic.

The ρ coefficients are allowed to differ across the panel members and the test also permits heterogeneous lags. Process (3) can be also specified in differences:

$$\Delta dy_{it} = \mu_i + \rho_i dy_{it-1} + \sum_{j=1}^{ki} \delta_{ij} \Delta dy_{it-j} + u_{it} \qquad t = 1, ..., T; \quad i = 1, ..., N \tag{4}$$

[4] Note that y_{it} is written in logarithms.

[5] The reader should remind that if the process has dimension N, originally one had N+1 countries, as one is used as benchmark.

where the *MADF* test becomes a joint test of the null $\rho_1 = \rho_2 = \cdots = \rho_N = 0$. Due to this pooled characteristic, the test, in principle, is rather sensible to the absence of a unit root in one of the series.

3.2 Multivariate unit root tests II: identifying the convergence club.

In the previous test, rejection of the null means that not all the members of the panel contain a unit root. Breuer et al. (1999) point out that there may be a mixture of $I(0)$ and $I(1)$ processes in the panel. However, as the tests are joint tests, rejection does not provide information about how many panel members follow the null and how many don't, being impossible to identify which are the stationary and non-stationary series. The two multivariate tests below, on the contrary, can identify which variables contain a unit root. Thus, they complement the *MADF* test, and should be applied in a second stage of the analysis.

Flôres et al. (1995)'s multivariate unit root test

Flôres, Preumont and Szafarz (1995) developed a multivariate testing strategy, *FPS* hereafter, that generalizes the multivariate pooled test by Abuaf and Jorion (1990), *AJ* hereafter. The tests in the strategy are multivariate versions of a Dickey-Fuller type test.

They consider that those tests that impose the same autoregressive parameter ρ for all countries do not allow to differentiate the order of integration across them. Even from an econometric point of view, to benefit from panel data, it might not be necessary to impose a common ρ. Moreover, unit root tests for a particular subset are more powerful if performed jointly with stationary series, because the latter help in weakening the influence of the non-stationary ones. Thus, they propose multivariate tests with different speeds of mean reversion in the autoregressive process:

$$dy_{it} = \mu_i + \rho_i dy_{it-1} + u_{it}, \qquad i = 1, ..., N \tag{5}$$

The strategy is based on first using a test on whether all the cross-sections have the same autoregressive parameters. As rejection of the null indicates that at least some of the series may be stationary, they suggest to continue with a sequential procedure, where Monte Carlo techniques have to be applied in order to obtain the critical values:

1. Under the first null hypothesis, the data generating process is based on the autoregressive model with $\rho_i = 1$, for the N countries. The system is estimated in a SURE framework using a Wald-type test. This is what we call the *first stage of the FPS* test. If the null is not rejected the sequence stops.

2. If the null is rejected, the parameters ρ_i are estimated by the $SURE$ technique, and the FPS test is used for the first time, on N null hypotheses:

$$H_0^i : \rho_i = 1, \qquad given\ \rho_{i'} = 1,\ for\ all\ other\ i'.$$

   The set of countries I_l for which the null is rejected is considered to be related to stationary series. If I_l has N elements, the sequence stops; if not,

3. A new data generating process for the null is assumed, in which the series $j \notin I_l$ have as slope parameters $\rho_j = 1$, while, for the series considered stationary, that is, $j \in I_l$,the slope coefficients are taken at their previous point estimates, $\rho_j = \hat{\rho}_j$. The second FPS test is then used to check, for each of the $j \notin I_l$, the null

$$H_0^j : \rho_j = 1, \qquad given\ \rho_{j'} = 1,\ for\ all\ other\ j \notin I_l.$$

   Notice that, in this case, a new estimation is not performed, only the (simulated) distribution under the null changes.

Breuer et al. (1999)'s multivariate test (SURADF)

Breuer et al. (1999)'s test allows for heterogeneous lag lengths (or serial correlation) across the panel, contemporaneous correlation among the errors, and different autoregressive parameters for each panel member under the alternative. In contrast to the $MADF$ test, separate null and alternative hypotheses are tested for each panel member within a $SURE$ framework. Similarly to the other tests, it has nonstandard distributions and the critical values must be obtained by simulation. The simulation produces critical values for testing the null hypothesis that $\rho_i = 0$, for each individual member of the panel, in the model below:

$$\Delta dy_{it} = \mu_i + \rho_i dy_{it-1} + \sum_{j=1}^{ki} \delta_{ij} \Delta dy_{it-j} + u_{it} \qquad t = 1, ..., T; \quad i = 1, ..., N \quad (6)$$

The critical values, as in the FPS case, are specific to the estimated covariance matrix for the system considered, the sample size and the number

of panel members. The procedure, which can be viewed as a multivariate version of the Augmented Dickey-Fuller test, allows identification of how many and which members of the panel contain a unit root.

4 Results

4.1 Econometric Findings.

The data used in the analyses are taken from the World Bank database. They include output and employment figures for the Mercosur members as well as Peru, Chile and Bolivia, for the 1960-1999 period. The series were transformed into logarithms, and productivity obtained as the logs difference[6].

In section 2, we argued that the failure of Argentina in keeping its currency board agreement can be, at least partially, explained by the diverging path followed by productivity in the two countries. Thus, before concentrating on Mercosur, we studied the Argentina - US case.

In Figure 1, the lack of convergence becomes apparent: the productivity differential between the two countries had been decreasing during the end of the sixties and most of the seventies; however, the gap widened during the eighties and, although it stabilized in the nineties, stayed at higher levels than those at the beginning of the sample.

We formally tested the convergence behavior of the two labor productivities using unit roots. The results appear in Tables 1 and 2. First, following the definitions given in section 3, we test for unit roots in the productivity differential. Although the presence of two unit roots is easily rejected both with the ADF and the Phillips-Perron test, in none of the tests it is possible to reject the non-stationarity (or divergence) of the differential. As unit root tests may have low power in the presence of structural changes (Perron, 1989), we applied several (unit root) tests that allow for endogenously determined breaks. The first two assume that the stochastic process has no trend and were proposed by Perron and Vogelsang (1992). Two possibilities are considered: a progressive (Innovation Outlier Model, IOM) or an instantaneous change (Additive Outlier Model or AOM). In contrast, the case of trending processes is studied in Perron (1997), who proposed tests for changes occurring in the mean of the process (model 1), in the trend (model 3) or in both (model 2)[7]. The results appear in table 2, where the rejection of the unit root

[6] All the data and results mentioned in the text but not displayed are available upon request to the authors.

[7] When testing for a structural change in trending processes, we have chosen the case of

hypothesis is not possible in any of the cases considered. However, it should be noted that the dummies capturing the structural changes are significant in most of the cases. More precisely, in the models allowing for a change in the mean find it in 1983, whereas those for a changing trend find it during the seventies.

Once the diverging path of Argentinean and US productivity has been assessed, we concentrate in the panel analysis and test for productivity convergence in the Mercosur area and associate countries (that is, Bolivia and Chile) plus Peru. Two benchmark countries were considered: Argentina, the one with higher productivity along the sample, and Brazil, the largest economy. In addition, two "convergence clubs" were tried: the first one consisting of Mercosur plus Bolivia, and the second one including all the countries in our sample (so that Chile and Peru are added).

The first stage of the FPS test is presented in Table 3, where the null of global non-convergence (common unit root) is rejected in two of the cases: when the benchmark country is Brazil, for the group including all the countries considered, whereas when Argentina is the benchmark, the null is rejected at 10% for the Mercosur plus Bolivia club. When applying the Wald test proposed by Sarno and Taylor (1998), as shown in Table 4, the non-convergence is rejected in the four cases considered. This implies that some degree of convergence is at least present in the two groups rejected by both tests, although it is not possible to identify which countries are converging.

In the second step of the analysis we sort out the converging countries using the two multivariate unit root tests that account for cross-sectional dependence among the elements of the panel. As described in the previous section, the testing procedures are different. Notwithstanding, the results obtained do not show important discrepancies.

Following the FPS test sequence, only two of the proposed clubs are considered (non-convergence could not be rejected for two of the groups). Table 5 shows that, when Brazil is the benchmark, it would converge with the other three Mercosur countries, and some weak (convergence) evidence, at the 10% level, being also exhibited with Bolivia. For Argentina as the benchmark, convergence is found with Bolivia and Brazil.

Table 6 shows the SURADF test results. As before, Brazil being the benchmark, there is convergence with the Mercosur countries. The difference is that no evidence is found for Bolivia in the bigger group. For Argentina as benchmark, the group of countries converging is somewhat larger, although the evidence is weaker, specially in the case of Paraguay. The small group

the change occurring progressively, with the exception of model 3, where the corresponding test is not defined.

confirms the Argentina-Brazil convergence, but, instead of Bolivia, Uruguay appears as a member, at the 10% level. Though bigger group was not analysed by the FPS - and here was the biggest difference between the two procedures -, it confirms convergence among Mercosur members, Bolivia being also included in the club. Qualitatively, it provides the same conclusions the bigger Brazil-as-benchmark group did, through the FPS procedure.

Table 7 summarizes the results at different aggregation levels, and shows that, basically, they are quite consistent. Strong evidence appears in favor of a Mercosur club.

4.2 Policy recommendations.

Any interpretation of the above results should bear in mind that, ideally, the more the countries at stake are close to equilibrium, the more the time series convergence tests make sense. Strict obeyance to this criterium would render impossible any exercise of this kind with South American economies. In order to minimise the consequences of such inherent instability, we chose a period where - in spite of spiralling inflationary spells in some areas - one could approach something close to reasonable in terms of labour productivity behaviour. Stopping the series at 1999 was also deliberate, to avoid introducing a few terminal points highly influenced by the Argentinean crisis.

Within this proviso, a clear sign of productivity convergence was found. As nearly half of the period was under the "regional integration push" - the 1991 to 1999 years with a formally established Mercosur, and the previous ten years with the bilateral trade agreements that preceded it -, the convergence obtained is mainly the result from higher integration of the economies, through increased trade flows among them (see, for instance, Calfat et al. (2003)). This positive message is counterbalanced by the (univariate) Argentina-US test, which reminds the importance of external constraints on regional decisions.

Mercosur should move forward to total free trade in goods and services within the bloc, to heighten the already started convergence of its economies. This first, and basic, policy measure to be pursued would help ensuring that a drastic turn in the empirical evidences doesn't take place. Moving to the further step of monetary integration - if the encouraging initial condition found here is maintained - requires the second, still missing, policy measure: the establishment of formal mechanisms of macroeconomic coordination.

Both policies could still lead to either disaster or negligible effects, however, if designed without an encompassing view, that takes into account the evolution of Mercosur's main external partners.

5 Concluding remarks.

The debate about a future monetary union in Mercosur has regained momentum as a regional alternative to dollarization or currency board strategies. In this paper, we stressed the importance of the analysis of productivity differences across Mercosur countries, as a key aspect to address before any attempt at monetary integration is pursued. Also, as a dramatic example, we argued that the diverging productivity path experienced by Argentina vis à vis the US, together with its commercial dependence on Brazil, became the most important obstacle to keep its peso-dollar parity commitment. Indeed, as expected, using time series unit root tests allowing for structural changes, it was not possible to find any evidence of convergence between Argentina and the US.

The main empirical investigation of this work concentrated on the extent of labor productivity convergence in the Southern Cone, at an aggregate level, using annual data for the period 1960-1999. The multivariate unit roots tests used provided significant improvements over previous ones employed in the study of productivity convergence. The results obtained in such multivariate context, taking into account cross-sectional dependence and including an extended Mercosur bloc, strongly favor the rejection of non-convergence. The convergence club is basically the full Mercosur members. In addition, using any of the tests and whatever the starting set considered, the two largest members - Argentina and Brazil - always show convergence.

These findings support the view that regional monetary integration in Mercosur cannot be discarded.

6 Tables

Table 1
ADF and PP unit root tests
Productivity differential US vs. Argentina (1960-1999)

Test		**Trend and intercept**	**Intercept**	**No det. term**
ADF	$\Delta difusar$	-5.3963***	—	—
	$difusar$	-2.1534	-1.4772	0.5136
PP	$\Delta difusar$	-5.4275***	—	—
	$difusar$	-1.9921	-1.2018	0.5975

Note: See MacKinnon (1992) for the critical values of the tests. The three asterisks denote rejection of the unit root null hypothesis at 1% critical value.

Table 2
Unit root tests allowing for structural changes
by Perron and Vogelsang (1992) and Perron (1997)
Productivity difference: US vs. Argentina (1960-1999)

Model	T_b	k	$\hat{\beta}$	$\hat{\theta}$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{t}_\alpha$
Selection criterion: t-sig ($Kmax = 4$)							
No trend-IOM	1983	0	—	0.0480	—	0.5387	-3.292
				(3.1492)			
No trend-AOM	1983	2	—	0.0891	—	0.4194	-3.334
				(8.182)			
Trend: Model 1-IOM	1983	0	-0.0007	0.0628	-0.0272	0.5026	-3.386
			(-0.784)	(2.576)	(-0.977)		
Trend: Model 2-IOM	1977	4	-0.0068	-0.3934	0.0197	-0.2719	-3.2524
			(-1.662)	(-2.603)	(2.575)		
Trend: Model 3-IOM	1974	1	-0.0079	—	0.0152	0.4778	-3.222
			(-3.698)		(5.526)		

Note: The critical values for the tests can be found in Perron and Vogelsang (1992) for the two first tests, tables 5 and 4, respectively; Perron (1997) tables 1(a), 1(d) and 1(g) for Models 1, 2 and 3, respectively. Asterisks would denote rejection of the null hypothesis of a unit root.

Table 3
First stage of the Flôres et al. (1996) test

Benchmark	Club	*Wald test*	99% crit.	95%	90%
Brazil	Arg, Bol, Par, Ur	11.48	19.19	14.92	12.46
Brazil	Arg,Bo,Ch,Par,Pe,Ur	24.25***	22.66	18.03	15.53
Argentina	Bo, Br, Par, Ur	17.62*	22.80	19.11	16.34
Argentina	Bo,Br,Chi,Par,Pe,Ur	12.62	23.45	18.29	15.25

Table 4
Sarno and Taylor MADF test (1998)

Benchmark	Club	*MADF*	99% crit.	95%	90%
Brazil	Arg, Bol, Par, Ur	16.44***	13.69	10.17	8.52
Brazil	Arg,Bo,Ch,Par,Pe,Ur	23.35***	23.04	16.21	13.84
Argentina	Bo, Br, Par, Ur	13.12**	14.89	10.14	8.36
Argentina	Bo,Br,Chi,Par,Pe,Ur	21.64***	18.39	13.73	11.21

Note: The asterisks (*), (**) and (***) denote rejection of the hypothesis of no convergence (non-stationarity) at 10, 5 and 1% respectively.

Table 5

Flôres et al. (1996) unit root test

Benchmark	Club	β	10%	5%	1%
Brazil	Arg.	0.9344***	0.9742	0.9658	0.9485
	Bol.	0.9713*	0.9751	0.9692	0.9568
	Chile	1.0039	0.8304	0.7857	0.6849
	Par.	0.8156	—	—	—
	Peru	0.9951	0.8679	0.8200	0.6960
	Ur.	0.8888	—	—	—
Argentina	Bol.	0.9191***	0.9922	0.9906	0.9874
	Br.	0.8634	—	—	—
	Par.	0.9717	0.9666	0.9567	0.9293
	Ur.	0.9591	0.9313	0.9063	0.8383

Note: The asterisks (*), (**) and (***) denote rejection of the hypothesis of no convergence (non-stationarity) at 10, 5 and 1% respectively. Coefficients for which there is no information on significance are related to series considered stationary (in the previous step, see text)

Table 6
Breuer et al. (1999) $SURADF$ test

Benchmark	Club	$SURADF$	10%	5%	1%
Brazil	Arg.	-1.622*	-1.504	-1.812	-2.319
	Bol.	-0.850	-1.505	-1.828	-2.475
	Par.	-3.123***	-1.418	-1.756	-2.560
	Ur.	-2.629***	-1.427	-1.752	-2.521
Brazil	Arg.	-1.780**	-1.235	-1.641	-2.335
	Bol.	-1.103	-1.641	-1.975	-2.613
	Chile	-2.268	-2.343	-2.601	-3.208
	Par.	-3.398***	-1.689	-2.093	-2.742
	Pe	-0.581	-1.753	-2.213	-2.747
	Ur.	-3.215***	-1.079	-1.501	-2.346
Argentina	Bol.	-1.352	-1.459	-1.888	-2.679
	Br.	-2.811***	-1.475	-1.793	-2.540
	Par.	-1.008	-1.543	-1.881	-2.633
	Ur.	-1.515*	-0.942	-1.642	-1.956
Argentina	Bol.	-1.875**	-1.481	-1.807	-2.420
	Br.	-2.606**	-1.475	-1.793	-2.625
	Chile	0.597	-1.343	-1.703	-2.471
	Par.	-1.540*	-1.465	-1.841	-2.321
	Peru	-1.055	-1.507	-1.851	-2.509
	Ur.	-2.485**	-1.412	-1.844	-2.526

Note: The asterisks (*), (**) and (***) denote rejection of the hypothesis of no convergence (non-stationarity) at 10, 5 and 1% respectively.

Table 7
Summary convergence results at different levels

7.1. From the individual tests.

Countries	*FPS test*	*SURADF test*
Bra-Arg	Yes	Yes
Bra-Bol	Yes(10%)	—
Bra-Chi	—	—
Bra-Par	Yes	Yes
Bra-Pe	—	—
Bra-Ur	Yes	Yes
Arg-Bol	Yes	Yes
Arg-Bra	Yes	Yes
Arg-Chi	—	—
Arg-Par	—	Yes(10%)
Arg-Pe	—	—
Arg-Ur	—	Yes

7.2. The clubs by test.

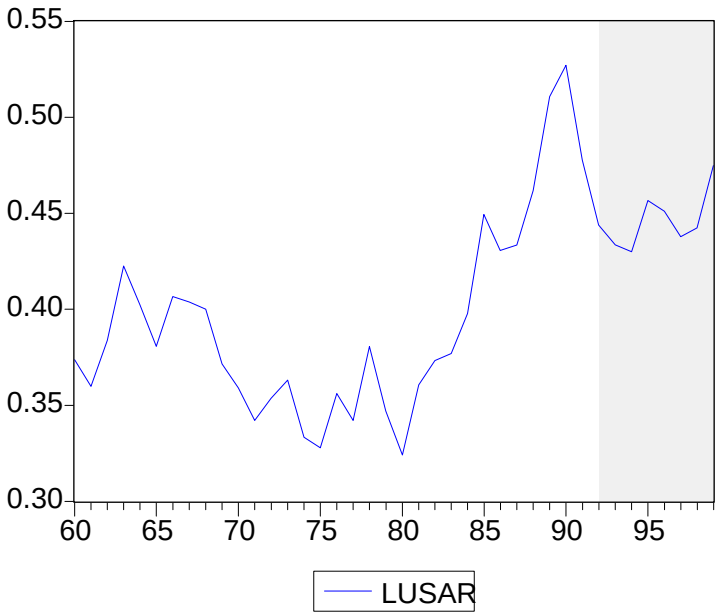
	Clubs	
FPS	Mercosur + Bolivia	Argentina+Brazil+Bolivia
$SURADF$	Mercosur	Mercosur+Bolivia

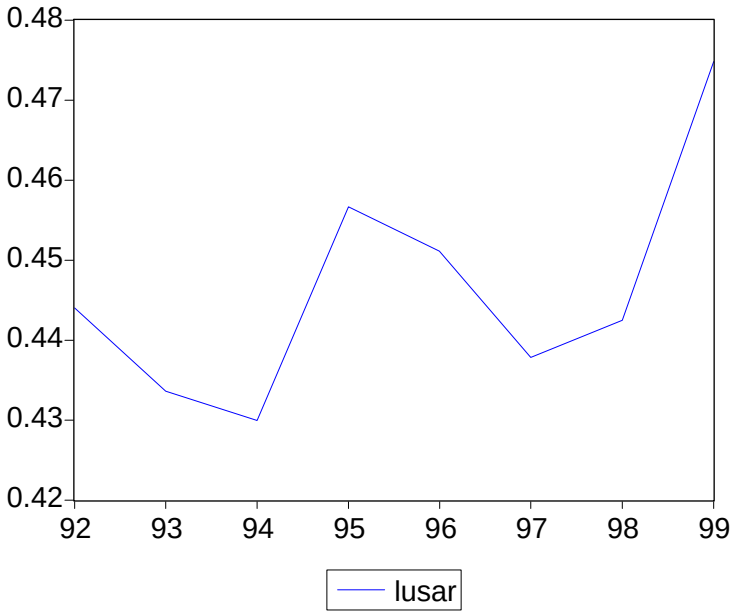
7.3. The clubs only.

Mercosur	Mercosur+Bolivia

7 Graphs

Graph 1: Productivity differential: US vs. Argentina





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